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ABSTRACT

The majority of shoulder injuries occurring in throwing sports involve the soft tissue structures. Injuries often occur when the unit is overstretched to a point near its greatest length, involving the elastic tissues. The other injury mechanism involves the contractural unit of the muscle, which occurs near the midpoint of contractions, involving largely the muscle fibers. The nature of the injury is modified by many things, including myostatic contractures of the joints and muscles, age and physical maturity of the patient, weight and type of object to be propelled, nature of propulsion, presence of weakness or fatigue, incoordination of the motion, amount of chronic degenerative changes present, and presence of previous injury with its fibrous scarring. Common stress-related injuries to the shoulder areas (anterior structures, rotator cuff and environs, posterior structures, glenohumeral articulation, neurovascular) are discussed along with generalized treatments. Suggestions are made for diagnosis, a year-round training program, early season practice, pre-game injury prevention and warm-up, post-game care, and treatment. (JD)

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THROWING INJURIES OF THE SHOULDER

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THROWING INJURIES OF THE SHOULDER

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The arm plays a critical role in all major sports, the sites of greatest trauma being the upper back, shoulder and elbow. The action of throwing is an extremely complex motion, which is finely coordinated to involve the entire body to a varying degree. The mechanism of delivery will vary greatly depending on the sport and the weight of the object to be propelled. The heavier the object and the greater the distance, the greater the power needed in propulsion and the more of the body is required, ranging from the entire body in throwing of the hammer and shot put, to the act of simply tossing the ball into the air while serving in tennis.

The act of throwing consists of five steps:

1) the initial stance;

2) the wind-up;

3) the cocking phase;

4) the forward action and downswing or acceleration of the arm;

5) follow-through.

The shoulder acts as a base for the arm with the ball in the hand, in much the same fashion as the handle of a whip, with the arm as a lash and a weighted tip on the end. Injuries in the throwing arm involve obvious, coordinated motion in the pivot motion, as well as the ipsilateral and contralateral leg motion are also essential to optimal delivery for minimal stress on the structures.

The athlete is exposed to all forms of injury and disability, as are those involved in ordinary everyday living, but with the additional stress and

strain applied to the structures modified by the sport in which he is participating. The individuals vary from the young pre-teenager in Little League baseball or football, to the elderly bowler or tennis player. Each sport presents its own individual problems, varying in degree and location in response to the stress and strain necessitated by the different sports.

The musculotendinous unit is the basic source of power. The majority of injuries occurring in throwing sports involve the soft tissue structures. Injuries to the musculotendinous unit, ligaments and joints occur largely when the unit is overstretched to a point near its greatest length, involving the elastic tissues. The other injury mechanism involves the contractural unit of the muscle, which occurs near the midpoint of contraction, involving largely the muscle fibers. The nature of the injury is modified by many things, including myostatic contractures of the joints and muscles, the age and maturity of the patient, the weight and type of object to be propelled, the nature of propulsion, the presence of weakness, fatigue, or incoordination of the motion, the amount of chronic degenerative changes present, the presence of previous injury with its fibrous scarring, as well as many more.

The biomechanics are very important in the breakdown of the throwing act and the method in which leverage is applied. The sequence is as follows:

1) Exert forces in the proper direction.
2) Exert forces in the proper time.
3) Exert forces in the proper sequence.
4) Exert forces over the greatest practical range.
5) Ground contact until released.

Baseball involves the greatest amount of acute and chronic stress and strain in throwing. The program for prevention of injuries is designed specifically for baseball pitchers, but can be altered and adjusted for any

throwing sport. The initial step in preventing injury problems begins with the pre-season and off-season training program. It should be followed into the season with pre-game preparation, daily care, and post-game handling in individual cases. The off-season is the time to allow previous injuries to clear up, as even the most minor injury can develop into a chronic disability, particularly in the face of the stress required in constant throwing over a period of time. All injured areas heal by fibrous scarring and, because of this, never completely return to normal, particularly in the case of recurrent repetition, which is necessary to the act of throwing, especially by the pitcher. It is important to keep the thrower under constant surveillance to prevent improper delivery, which could cause permanent disability to the athlete. This not only includes the upper extremity but all portions of the body. The complete act of delivery includes the arm, footwork, leg action, hip and trunk rotation, as well as action of the opposite arm. Injuries of any type, which break up this coordinated movement, can cause abnormal strain on an area. The need for repetitive deliveries further multiplies the injury with the resultant stress and strain which may severely involve or shorten the individual's career.

The act of delivery itself consists of many variations, ranging from the overhand delivery through three-quarters, the side-arm, and even to underhand or submarine type. In addition, in other sports, the variation is greatly multiplied as well. The thrower, if he generates as much force or power as is possible, begins with the wind-up, following through and reaching back to the limits of external rotation, abduction and extension of the shoulder. This is then followed by the whipping forward with internal rotation and adduction of the shoulder, and extension of the elbow. This is the process in which extreme valgus strain is placed on the elbow. The motion progresses into

follow-through, with the hand and weighted object attempting to actually throw the shoulder at the batter to obtain maximum speed. In general, the type of delivery determines the areas of greatest stress, with the overhand delivery delivering the maximum stress to the shoulder, wrist and back, the side-arm producing stress primarily to the elbow and back. These joints are affected by:

1) the athlete's conditioning, flexibility and strength;
2) pre-game warm-up of the musculotendinous structures involved;
3) type of delivery;
4) force of delivery;
5) variations and peculiarities of the stance;
6) age of athlete and degree of degenerative changes present;
7) running too hard or too long during a period of time with too many extra innings relative to the situation;
8) throwing under adverse, traumatic conditions, such as cold weather, too much exposure, or extremely hot weather, causing undue fatigue and its sequelae;
9) the presence of other physical disabilities, such as weight problems, infections, illnesses of any type, or mental tensions.
10) collision injuries with teammates, opponents, or while sliding into base;
11) immaturity of the individual, the amount of throwing, which is particularly important in pre-teenagers, in Little League, and similar competition;
12) abnormal delivery or change of delivery due to compensation for a musculoskeletal injury.

There are many more causes rarely seen which are too numerous to mention.

COMMON THROWING INJURIES OF THE SHOULDER

The nature of the stress-produced clinical entities about the shoulder may be classified into groups ranging from the acute, consisting largely of soft tissue injuries, through subacute to chronic in which more permanent structural changes are present. In the latter, acute flare-ups or recurrences occur, causing functional loss and symptomatic disabilities.

Baseball is the major throwing sport with multiple injuries possible. Each sport may show similar findings to a variable degree, modified by repetition, type of delivery, weight and shape of the object to be propelled, distance to be thrown, longevity, and many other things described before.

The shoulder may be divided into sections, with injuries occurring in the different phases of the throwing act, due to intrinsic dynamic strain or extrinsic-stretch strain accentuated by a myostatic contracture which may be present.

Acute injuries to the joint and its supporting ligament and musculotendinous structures occur with overstretching anteriorly and posteriorly. This occurs anteriorly in attempt to gain power by increasing external rotation. It occurs posteriorly when an elongation occurs in follow-through. Acute injuries also occur when muscle power is impaired during reciprocal contraction and relaxation, due to weakness, fatigue, incoordination, and position in the length-tension curve.

Few injuries occur in the initial stance and early part of the wind-up. However, as the shoulder goes into the late wind-up and cocking phase, the anterior-internal rotation structures are placed under stretch preparatory to contracture in the acceleration phase. The stresses that occur in alternating stretching and contracture of the musculotendinous and capsular unit, cause minute microtears at their insertions, with the resultant inflammatory re-

sponse which will usually respond to rest and other conservative therapy.

The shoulder may be divided into sections as determined by anatomical position. These will be listed individually in the different sections and occasionally overlap, due to the anatomical and functional nature of the structure.

THE ANTERIOR STRUCTURES

1. Capsule
2. Anterior Deltoid
3. Pectoralis Major
4. Latissimus Dorsi
5. Teres Major
6. Subscapularis
7. Long Head of Biceps

The anterior structures which are potential candidates for injury are the capsule, anterior third of the deltoid, pectoralis major, latissimus dorsi, teres major, subscapularis and long head of the biceps.

The pectoralis major is placed under stress in the cocking phase. The stress is enhanced with overdevelopment. contracture through weight training, or with postural malposition. The tender area is at its insertion posterior to the bicipital groove. Injury is most often seen in baseball and javelin throwers.

The fibers of the anterior deltoid and pectoralis major are often injured in the early acceleration stage, as are other internal rotators. The subscapularis is also injured when its contraction occurs after being stretched into external rotation and abduction. Symptoms include localized pain and tenderness over its insertion at the lesser tuberosity. The other internal rotators may be similarly involved.

Acute ruptures do occur, but are rare. The latissimus dorsi, which is prone to internal rotation myostatic contracture, and the pectoralis major, are the most apt to completely tear.

Bicipital tenosynovitis is a relatively common cause of anterior shoulder pain, with tenderness along the long head of the biceps. This is especially seen in overhead throwing and tennis, when the tendon tends to ride over the lesser tuberosity during external rotation-abduction. Anatomical variations of the bicipital groove occur. The small, tight-roofed, sharp-walled canal is more apt to cause irritative changes, while the canal with a small, lax, transverse humeral ligament, with a shallow obliquely-angled wall, is more apt to undergo subluxation.

The biceps tendon usually subluxes medially because of its angle as it passes from the bicipital groove to the glenoid. This also occurs because the lesser tuberosity is less prominent than the greater tuberosity. This occurs as the shoulder goes from internal rotation to external rotation and back again. This is more commonly found in football passers because of the heavy object to be thrown and the need for additional pushing action. It is also prevalent in underhand throwing, as in softball, due to the forceful supinator strain, plus arm and forearm flexion. Rest and conservative means may help, but, with marked disability, surgery may be required. A proximal rupture of the long head of the biceps may occur, but does so most often in the middle-aged athlete.

THE ROTATOR CUFF AND ENVIRONS

1. a) Supraspinatus
   b) Infraspinatus
   c) Teres Minor
2. Long Head of Biceps

3. Subscapularis

4. Acromion

5. Coraco-Acromial Ligament

6. A-C Joint

Complete acute tears of the rotator cuff are extremely rare in the young athlete. They are diagnosed by clinical loss of cuff function and positive arthrography. Small tears and partial tears are more common but difficult to diagnose accurately. This is despite the increased use and aid of arthroscopy. These problems, along with subacromial-subdeltoid bursitis and subsequent impingement syndrome occurring under the acromial arch, are more common and functionally disabling in the middle-aged athlete. They are more often seen in the veteran after long-term repetitive stress. These injuries occur in the midportion or acceleration phase of the throwing act. Function may be improved by dropping the shoulder to a three-quarter or a side-arm delivery. The painful arc syndrome can be produced by impingement of the supraspinatus tendon, the biceps tendon, or the greater tuberosity of the humerus against the coraco-acromial arch. The risk of impingement is increased by a greater volume of structures passing beneath the arch and by a reduced space available for the cuff material. Microtrauma from throwing may lead to inflammation that increases the volume of the musculotendinous unit. This increases the risk of further damage symptomatically and functionally.

The acromion, coraco-acromial ligament, and coracoid, form the arch under which the humeral head and its overlying rotator cuff glide during the throwing act. Where conservative treatment is not successful, surgical repair of the tears of the rotator cuff is indicated. For younger individuals, particularly swimmers, excision of the coraco-acromial ligament alone has frequently been helpful in relieving the impingement. This same procedure has

not been successful in many adults with impingement syndrome.

The A-C joint may be involved in injuries during throwing. Each 2 degrees of elevation of the arm is associated with 1 degree of rotation of the clavicle, causing impingement in certain individuals during the throwing act. Excision of the distal end of the clavicle is often helpful in relieving the symptoms. In longstanding cases, spurring at the A-C joint will add to impingement, causing even more reduction in the space for the cuff to rotate.

THE POSTERIOR STRUCTURES

1. Posterior Capsule
2. Long Head of Triceps
3. Teres Minor

Repeated stretching of the posterior structures during follow-through may cause inflammatory changes at the attachment of the cuff. Inflammatory changes are also found at the insertion of the long head of the triceps on the posterior-inferior glenoid. Teres minor strain is localized over that muscle due to a similar mechanism, but with pain radiating along the axillary border of the scapula as well. Local osseotendinous ossification occurs, progressing to spur formation, causing impingement and possible fracture of the spur. By this same process, bodies are extruded into the glenohumeral joint.

THE GLENOHUMERAL ARTICULATION

1. Dislocation - a) Anterior
   b) Posterior
2. Subluxation - a) Anterior
   b) Posterior
3. Glenoid Labrum
4. Humeral Head OA Changes
5. Glenoid Spurring

6. Foreign Bodies

7. Epiphyseal Injuries

Anterior or posterior subluxation of the shoulder occurs during the cocking phase, but is more commonly due to trauma. In hyperflexible lax-jointed individuals, anterior combined with posterior laxity makes the diagnosis difficult. When laxity is present to a significant degree, treatment is difficult, even by surgical means.

Posterior subluxation of the shoulder can occur in a follow-through as the humerus is brought down into adduction and internal rotation.

Degenerative changes in the glenoid labrum have been described by Andrews, and arthroscopic debridement has been successful in a large series of cases. However, these have not been followed over a long enough period of time to determine whether or not the results post-surgically will be permanent in a significant percentage of cases.

The humeral head may show traumatic osteoarthritic changes, with ridging caused by the repetitive external rotation forces in the throwing motion resulting in long-standing compression against the glenoid. This groove is more inferior than that seen in the Hill-Sachs lesion in recurrent anterior dislocation.

Glenoid spurring and foreign body, either from fracture of the arthritic spurs or osteochondral fragments from microfractures of the articular surface, may be seen in the veteran throwers.

In children with open epiphyseal plates, stress may cause local changes, as well as abnormal future bone growth. Osteochondrosis of the proximal humeral epiphysis has been described and responds well to rest and rarely causes any long-term disability.

RARE CAUSES OF THE POSTERIOR SHOULDER PAIN

1. Suprascapular Nerve Compression
2. Quadrilateral Space Compression
3. Myositis Ossificans
4. Latissimus Dorsi Contracture with Limited External Rotation
5. Post Deltoid Injuries

Suprascapular nerve compression with local discomfort involvement and atrophy in longstanding cases to the supraspinous and infraspinous muscles may be found.

The quadrilateral space syndrome is an uncommon entity, caused by a compression of the posterior humeral circumflex artery and axillary nerves or one of its major branches in the quadrilateral space. The pain component of this syndrome is poorly localized to the anterior aspect of the shoulder. Due to its dermatomal involvement, the paresthesias have a nondermatomal distribution in the arm, forearm and hand. Forward flexion and/or abduction and external rotation of the humerus aggravate the symptoms. Discrete point tenderness is usually found posteriorly in the quadrilateral space. Patients with appropriate history and physical findings should have a subclavian arteriogram. A positive arteriogram shows occlusion of the posterior humeral circumflex artery with the arm in abduction and external rotation. Surgical decompression should be considered if the patient has sufficient symptoms with no relief after a long course of conservative care, or an arteriogram indicates occlusion of the posterior humeral circumflex artery. Many patients have been seen with a normal subclavian arteriogram for thoracic outlet syndrome, but have a compressed posterior humeral circumflex artery with the humerus in abduction and external rotation.

Myositis ossificans may be seen but is usually due to trauma to the

vascular area in the posterior shoulder. Contraction of the latissimus dorsi with limitation of external rotation may be painful in the posterior shoulder area.

NEUROVASCULAR SHOULDER PROBLEMS

1. Arterial Occlusion
2. Venous Occlusion - Subclavian
3. Thoracic Outlet
4. Brachial Plexus and Cervical Roots Syndrome
5. Peripheral Neuropathies

The axillary artery is divided into three portions. The first lies proximal, the second deep, and the third distal to the pectoralis minor muscle. During the wind-up or cocking phase, the arm is brought into abduction, extension and external rotation or the so-called hyperabduction position, and the second portion of the axillary artery may be occluded by the pressure of the overlying pectoralis minor muscle. In these individuals, with each pitch the transient occlusion may occur, and, in certain cases, sufficient local damage occurs to produce intimal damage and subsequent thrombosis. Rapid fatigue and poor control appear in association with local tenderness, absent pulses, cyanosis and decreased skin temperature. The treatment is vascular in nature A sympathectomy has been temporarily successful in certain individuals.

The so-called "effort thrombosis" of the subclavian vein has occurred in throwers, with the exact pathophysiology still controversial. The currently held concept is that the syndrome results because of mechanical obstruction, with or without concomitant venous thrombosis of the subclavian vein at one or more points as it passes out of the thoracic inlet. The symptom usually is found on the dominant side in a young active male, with acute onset of diffuse

swelling and distention of the superficial veins accompanied by cyanosis. The sensation of heaviness, along with the increase in size and elevated venous pressure, is present. The onset is often sudden and may disappear with the arm in the neutral position. The compression occurs most commonly between the clavicle anteriorly and the first rib posteriorly, with other factors, such as the fibrotic anterior scalene, abnormal fibrous bands, a rigid costoclavicular ligament or an extremely tight pectoralis minor also possibly causing compression. The peripheral neuropathies with involvement of the brachial plexus or cervical nerve roots, as well as thoracic outlet syndrome, may be found treatable by conservative means.

HEAVY THROWING SPORTS

1. Scapular Stabilizers
2. Interscapular
3. Scapulo Costal

The heavy throwing sports with the heavy projectile and momentum of follow-through place marked traction stress on the anchoring structures posteriorly. These include the interscapular group and scapular stabilizers. Medial scapular tendinitis may go on to spur formation, especially at the superior angle and superior one-third of the medial border of the scapula.

STICK SPORTS

1. A-C Joint
2. S-C Joint

The stick sports golf and hockey use a propelling force across the body with maximum torque or force produced directly along the clavicle. This often involves the acromioclavicular joint. The sternoclavicular joint is only rarely involved in this manner. The lesions vary from synovitis and osteochondritis to severe traumatic osteoarthritis.

FRACTURES

1. Traumatic
    a) Direct
    b) Torque
2. Avulsion
3. Osteochondral
4. Stress
5. Epiphyseal

Fractures may occur from direct force, which is the more common mechanism in the contact sports. All sports are associated with a certain amount of contact, and fractures result either from direct physical contact with opponents or from falls. Torque involved in throwing actions may cause comminuted spiral fractures of the humerus. A fracture of the posterior ribs may occur on the ipsilateral, lateral or contralateral side.

The various avulsion fractures are infrequently found about the shoulder.

Osteochondral fractures of the humeral head, involving direct contact, may occur. Examples include the humeral head compression fracture seen in chronic dislocation, which is called a Hill-Sachs lesion, and a compression fracture of the posterior glenoid.

Stress fractures may occur in the first rib, and usually involve the contralateral side. The fracture occurs at the thinnest, weakest portion of the rib, in the subclavian groove between the attachment of the scalenus anticus and scalenus medius muscles. The serratus anterior also attaches at this level. Similar fractures in the lower three floating ribs have been described, as well. A sudden, vigorous contracture of the external oblique muscles, interdigitating with the latissimus dorsi, serratus posterior, inferior and internal oblique muscles at the tips of the tenth, eleventh and

twelfth ribs, may cause stress fractures of these ribs.

In addition to the previously mentioned epiphyseal changes, stress fractures may occur at the epiphyseal lines, influencing not only bone integrity but also future bone growth to a varying degree. While this is most common in the medial humeral epicondyle at the elbow, other areas, including the proximal humeral epiphysis, may be involved.

MECHANISMS OF INJURY OF THE THROWING ACT

The five phases of the throwing act specify the action required in baseball pitching, but, with minor alteration, can describe the other throwing, stick, or racquet sports.

Should incorrect techniques be employed, the repetitive and abnormal stresses would result in injury to the structures involved.

The throwing of a football differs from baseball, in that there is a shorter wind-up, less forward action, and a weaker follow-through. It uses a larger, heavier object, and more of pushing action.

A javelin requires a similar mechanism as baseball, but the majority of stress is at the elbow.

In putting the shot, a strong pushing motion of the heavy object to be propelled and its forceful follow-through put tremendous stress on the muscles anchoring the shoulder girdle.

The hurling of the discus or hammer substitutes centrifugal force for linear force, with different terminal movements in their release. These seldom present serious injury problems but, with improper release, can cause traction-type injuries.

The underhanded mechanism required in bowling, softball, and curling, is mostly a flexion action with a shorter excursion and less force applied on the biceps and anterior shoulder.

The batting, stick, and racquet sports cause different type stresses but present many similarities to those involved in throwing. It has been said that in baseball, the shoulder gives power and control. In the field sports, it acts principally as an anchoring mechanism; however, in the racquet sports, it serves chiefly as a fulcrum for the forearm.

The major force in the racquet sports is on the elbow and forearm, but, in tennis, especially on higher competitive levels, significant stress on the shoulder, similar to that in baseball pitching, may be present.

The major propelling action in golf and hockey is across the body, rather than in front of it, with the major forces being along the clavicle, scapula, and especially at the acromioclavicular joint. Baseball requires a more level, controlled swing, with less torsion and injuries.

The time in the throwing act is very significant, along with precise localization of the point tenderness. This is especially true in the anterior and posterior aspects of the shoulder joint, where many potentially injured structures in close approximation are lying under heavy musculature.

DIAGNOSIS

An accurate history along with the physical examination usually identifies the problem.

A thorough knowledge and understanding of the throwing act is paramount in accurate localization of the stresses involved. The stresses vary with individual sports but, when correlated with the specific function of the anatomic structure, will aid greatly in diagnosis and treatment of the problem.

X-rays, including multiple views as indicated, are imperative in accurate diagnosis. Arthrography has proved very helpful, especially in cases of rotator cuff injuries. Cine radiography has been of value where possible

instabilities exist. Bursograms, image intensifiers, fluoroscopy, EMG, laminograms and other tests may rarely be useful. The use of arthroscopy has rapidly increased both diagnostically and surgically.

Manual muscle testing and placing the muscle or tendinous unit on stretch will aid in the diagnosis of musculotendinous strain.

YEAR-ROUND TRAINING PROGRAM

A year-round training program will help prevent disabilities, increase the effectiveness of the athlete, in addition to strengthening and limiting any pre-existing problems. Here are a group of suggestions which can be tailored in any manner to fit the individual involved:

1) Treatment for any pre-existing injury to minimize scar formation and slow down chronic changes.
2) Dietary disciplining of food and drink intake, particularly to prevent weight gain. Overweight is among the greatest handicaps to baseball players, especially to a pitcher who is expected to throw hard. The excess fatty tissue causes decreased muscle strength, working as a brake on the contracting muscle.
3) Adherence to a program of running, at least 3 days a week, during the early part of the off-season, increasing to daily running period as the season nears.
4) The year-round throwing program, which includes a study of the previous year's films; isolate and overcome any faulty throwing habits.
5) Participation in other sports such as golfing and handball and others to improve the coordination, self-control, precision, and reflexes. Daily stretching exercises, including hanging from a horizontal bar.
6) Individualized exercise program tailored to fit the specific needs,

including stretching and muscle strengthening exercises. Pre-season physical examination, with a check-up for any systemic diseases, postural imbalance, or abnormalities of the back, feet and legs.

7) Other activities used are: swinging of a weighted bat, walking with weighted shoes and throwing with the weighted ball.

EARLY SEASON PRACTICE

The players should be checked carefully, as far as their general physical condition is concerned. Particular note should be taken of weight, speed and endurance. The conditioning program should involve running to build strength and endurance in the legs, a lack of which can be a prime cause of upper extremity problems.

Do not allow the pitchers to throw the ball hard at the onset of practice season. The fast ball causes early-season problems, and hard breaking curves should not be thrown during the first week. Pitchers may be allowed to spin curves the first day, but not throw the ball to break hard.

Gradual increase in the force of throwing must be carried out to meet the individual situation and will vary from one pitcher to the next. Again, general conditioning, proper balance, and the correct delivery are important and should be carefully observed and corrected if any deficiency is found.

In the early-season practice, the number of innings pitched should be limited, beginning with each pitcher throwing two to three innings (depending on the number of pitches thrown) and gradually adding an inning each game or period of time until the individual can go the full route. A period of time necessary for each individual to rest following a game will vary, but, generally, an individual will need a three- to four-day period of rest after a game. This will be varied in relief pitchers, who pitch a lesser number of innings.

During the period between pitching, general conditioning exercises should be carried on, especially running, with individual muscle strengthening and stretching carried out as indicated. Other modalities and physical therapy can be carried out as needed.

PRE-GAME INJURY PREVENTION

The following are some suggestions to be carried out prior to the game, being tailored to fit the individual need:

1) moist heat - 20 minutes. This may be followed with an ice rub or cold wet towel rub;

2) stretching exercises to the upper extremity. Stretching plays an important part in preparing the pitcher for the game. Not only does it loosen up the arm, making it more flexible for optimal delivery, but it may save as many as 20 pitchers from the pitchers' pre-game warm-up and may provide the extra boost which is so important later in the game. Our pre-game routine is divided into 12 parts.[1]

POSITION:

SIDE-LYING

A) 1) Massage shoulder with analgesic

2) Scapular press

3) Abduction

4) Rotation, external-internal

5) Extension

POSITION:

BACK-LYING

B) 1) Extension - adduction

2) Rotation, external-internal

3) Horizontal flexion

4) Abduction

5) Forearm range of motion exercises

6) Wrist and finger range of motion exercises

7) Shake extremity

HANG-STRETCH

C) 1) An exercise to use following the stretching with the horizontal bar from which the pitcher, with the full body weight suspended from one arm, revolves slowly for 30 to 60 seconds, stretching the shoulder and arm muscles which open the joint, opening and loosening the joint structures

2) The use of calisthenics prior to progressive warm-up

3) Keep pitcher warm until ready to pitch, regardless of climatic conditions

PRE-GAME WARM-UP

It is extremely important to obtain the optimal degree of preparation for the maximal performance of the throwing arm.

Thus, to "warm up" or "loosen up" is most important in the thrower's repertoire. Each sport may require a different type of warm-up to meet its specific needs. It has been noted that external rotation of the shoulder increases with a concomitant decrease in internal rotation during warm-up. This is a permanent finding in the veteran pitcher.

1) Use limbering exercises without throwing.

2) Work up a sweat before going into the box by use of calisthenics.

3) Begin warming up at a distance shorter than form the pitcher's box to the plate.

4) Gradually increase the distance as the arm limbers up.

5) Begin warm-ups with slow pitches, gradually increasing the speed as

the arm loosens up.

6) Do not throw curve balls until the arm is warm.

7) Always throw at the mitt as a target.

8) Never throw to bases as in pick-offs unless arm is thoroughly warmed up.

9) Keep arm under wraps at all times when not pitching.

10) On cold, windy days, additional massage may be necessary beginning with the fingertips, moving gradually into the wrist, the elbow into the shoulder, and should include the neck and back. An analgesic rub is helpful in maintaining warmth in the throwing arm, as well.

A specific pre-game warm-up routine may be as follows:

TOTAL: 15-20 minutes

1) 30 straight balls of medium velocity

2) 10 curve balls

3) 10 sliders

4) 10 fast balls at increased velocity

5) alternate with sets, 5 pitches of varying types

TOTAL: approximately 80 pitches

THEN: 5-minute rest prior to onset of game

POST-GAME CARE

Strenuous use of the arm during long, hard throwing causes an increase in vascular return to the soft tissue structures. Resultant hyperemia and edema formation occur with soft tissue swelling. In cases where this is excessive, methods of treatment which have been used include compression (intermittent compression machine), oral enzymes, and gentle massage, beginning distally in an attempt to milk the edema fluid from the extremity.

We have found the ice bath regimen to be helpful in certain cases. This

consists of immersion of the arm in the ice bath for five seconds, then removal for five seconds. Repeat for ten seconds, then fifteen, until able to keep the arm in the bath for fifteen to twenty minutes. Only the areas of irritation need to be immersed in the ice bath.

Once the pitcher is in good physical condition and in a regular rotation, pitching every four or five days, we do the following (naturally, this will vary with some pitchers):

1) Use same limbering-up exercise (as mentioned in pre-game) every day except two days prior to pitching;
2) Throw either during batting practices or throw on the side every day, except two days prior to pitching. Throw at least 70 pitches after you have warmed up.
3) Do general exercise, as mentioned in the training program, and run at least 30 minutes each day, except the day before pitching. Be sure to run distance as well as sprints.
4) The day before you pitch, do not throw, run or exercise.

Following an injury or a period of inactivity, this program may be useful for gradual return to normal throwing.

OBJECT: To stretch and strengthen the arm and help the individual return to normal throwing motion.

1) Long, easy throws from deep outfield.
   30 minutes on 2 consecutive days.
   Then rest the arm for one day.
2) Stronger throws from mid-outfield on 5 to 6 bounces.
   30 minutes on 2 consecutive days.
   Then rest the arm for one day.
3) Strong throws from short outfield, straight trajectory on one bounce.

30 minutes on 2 days.

Rest a day.

4) Return to the mound or other normal position for usual activities.

TREATMENT

The athlete is generally young and in good physical condition, although members of the older age group are becoming participants in increasing numbers. The physician treating these individuals should be aware of these characteristics and that they are highly motivated, cooperative, and usually with good mental attitude to succeed in their particular sport.

The great desire to return to competition is helpful to those rendering therapy, and understandably the treatment pattern is different than that seen in the usual medical practice.

The treatment involving the throwing arm is concerned largely with the musculoskeletal system and much less frequently with injuries to other systems. The majority of injuries respond to conservative therapy.

1) REST

2) PHYSICAL THERAPY MODALITIES

3) HEAT-ICE

4) EXERCISES

5) TECHNIQUE

6) MEDICATIONS

   A) ANALGESICS

   B) ENZYMES

   C) ANTI-INFLAMMATORIES

   D) STEROIDS

   E) MUSCLE RELAXANTS

7) REASSURANCE

REST

Musculotendinous and ligamentous injuries are classified Grade I (mild), Grade II (moderate), and Grade III (severe), depending on their progressive degree of severity.

Rest is essential for soft tissue healing, and all other adjunctive treatment aids help in decreasing the reaction and clearing up the inflammatory response of injury. This is especially true of the acute injury, and also of flare-ups in the chronic cases.

The exact period of rest varies widely with the type, severity, and location of the injury, along with the needs of the patient.

PHYSICAL THERAPY MODALITIES - HEAT AND ICE

The use of thermotherapy and cryotherapy are important adjuncts in the treatment of the throwing arm. They can be employed together or separately. Both are an antispasmodic and analgesic. Heat is usually applied initially to stimulate circulation and facilitate warm-up. Ice is usually utilized after an exercise session to reduce swelling and subsequent inflammation. Prevention of swelling is important, as swelling is the worst enemy of the injury. One of the main values of these modalities is that they relieve pain and allow the athlete to begin exercise.

EXERCISE AND TECHNIQUE

Exercise, even minimal isometrics, should begin as soon as possible, as between one and three percent of the athlete's strength is lost with each day's rest post-injury. Therefore, early exercise, performed in a pain-free range of motion, will reduce the athlete's recovery time. The exercise program should include flexibility, strength and endurance throughout shoulder forward flexion, backward extension, horizontal flexion, horizontal extension, abduction, adduction, internal rotation, and external rotation; elbow flex-

ion, extension, supination, and pronation; wrist flexion, extension, abduction, and adduction. The movements should be exercised individually and collectively, the athlete progressing from isometric to isotonic and/or isokinetic exercise.

With exercise and the return of strength, flexibility and endurance, the athlete begins his normal throwing routine. At this stage, technique and coordination are essential. The athlete who changes his throwing form, due to an injury, often invites re-injury or associated injury to other structures. At this point, the coach or trainer who is familiar with the athlete's throwing style is the most important individual in the athlete's treatment. The athlete is not allowed to throw until he can do so virtually pain-free in his normal form. His exercise session is halted when he begins substitution or deviation from this form.

Cardiovascular conditioning must be maintained throughout the athlete's treatment. The exercise bicycle is an excellent cardiovascular conditioner for the individual who cannot run due to the jarring discomfort in the shoulder. A minimal program of 30 minutes a day, with the pulse rate above 120, is mandatory.

MEDICATIONS

Medications do not prevent injury. They are used as aids in curing, regulating, and comforting the patient.

Analgesics are primarily used to obtain comfort for the injured athlete. These are divided into those used for mild pain, the prime example being salicylates, to those for severe pain which are rarely needed (certainly not by a participant), with Morphine, Demerol, and Codeine being examples in decreasing strength. Salicylates are occasionally helpful in cases of mild inflammatory reactions 20 to 30 minutes prior to a contest.

Enzymes of the injectable type combined with Xylocaine as a carrier and a steroid to decrease reaction, may be used to break up local hematomata, but are not commonly used in throwing injuries. Oral enzymes are of questionable value.

Anti-inflammatories have been widely used in athletic medicine. They are useful in the more chronic inflammatory conditions but also in acute injuries. These drugs may cause troublesome complications and should be used in short courses only.

We use a graduated schedule of Phenabutazone or a derivative as follows:

200 mg QID x 2 days

200 mg TID x 2 days

100 mg TID x 3 days

Similar anti-inflammatory drugs which may be useful are Indocin, Motrin, Tolectin, Naprosyn and others.

Oral administration of corticosteroids is used infrequently, if at all. Injectable steroids are useful in selected but not repeatedly, or into tendon or joint. For example, a series of not more than three injections two weeks apart may be used in trigger areas, AC joint for sprain, etc.

Muscle relaxants, such as Methocarbamol or Carisoprodol, and tranquilizers may be used orally to relieve muscle spasm and occasionally IV in severe, acute spasm. Many, especially the tranquilizers, give some sedation and may aid in this fashion.

REASSURANCE

The average athlete is strongly motivated to resume athletic activity on recovery, but there is a small percentage who lack sufficient motivation. Each person has a different reaction to injury, and it may vary for some reason during the period of recovery.

occurring by overstretching of the elastic fibers (extrinsic loading) and by contraction of the muscle, usually near its midpoint (intrinsic loading).

The nature of the injury is modified by many things, including myostatic contracture of the joints and muscles, the age and maturity of the patient, the weight and type of the object to be propelled, the nature of propulsion, the presence of weakness, fatigue, or incoordination of motion, the amount of chronic degenerative changes, the presence of previous injury with its fibrous scarring, as well as repetitive microtrauma, and many more.

Accurate definition of the pitching act allows coordination of injury with its position in the phase, as well as anatomical location during clinical exam.

The most common stress-related injuries are discussed, along with generalized treatment. Because of the paramount importance of the throwing arm in sports, we feel that it is imperative that a generalized year-round training program, pre- and early-season conditioning program, careful pre-game care and warm-up, and diligent post-game care will help prevent disabilities and increase the efficiency of the athlete. We hope these suggestions will be of value to decrease the chances of injury and possible chronical disabilities.

Many things, such as release from an unpleasant obligation, fear of pain, disability, re-injury, and loss of social status, may be psychological factors in delay of recovery. They may also be used as salvages of pride and rationalization of decreasing performance in the aging athlete.

This phase of treatment is extremely important, and the best treatment is prevention. The psychological aspect is begun at onset of injury and followed closely until return to activity. If ignored, complete recovery may never occur.

IN GENERAL

Mild injuries are treated with a relatively short period of rest, medication and modalities aiming at rapid return to function with minimal reconditioning required.

Moderate injuries need a more prolonged period of rest, medication and therapy with an individualized rehabilitation and exercise program prior to return to activity.

Severe injuries often need surgical reconstruction with subsequent prolonged rest and more extensive rehabilitation and exercise.

CONCLUSION

The arm plays a critical role in all sports, the sites of greatest trauma being the shoulder, elbow and upper back. The action of throwing or swinging is a very complex motion coordinated to involve the body as a whole.

The mechanism of delivery will vary greatly by the sport and the weight of the object to be propelled. Each sport presents its own individual problems, varying in degree and location in response to the stress and strain. The majority of these injuries involve the soft tissue structures initially, with articular and bony changes a subsequent finding.